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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the axial flow turbine nozzle and axial-flow turbine which reduced paragraph loss of a turbine and aimed at improvement in effectiveness by making the optimal the length of an inside-and-outside peripheral wall.
[0002]
[Description of the Prior Art] In the large-sized axial flow steam turbine and gas turbine which are used for a general thermal power station etc., it usually has two or more turbine paragraphs, and sequential passage is carried out from an upper paragraph to a down-stream paragraph, the working fluid of elevated-temperature high voltage is expanded, and an output is generated by transforming heat and pressure energy into rotational energy through the energy of speed. Each paragraph consists of 1 set each of the nozzle cascade which arranged many nozzles in the hoop direction, prepared the inside-and-outside peripheral wall, and formed the annular path, and the bucket train which implanted many buckets in the perimeter of the axis of rotation arranged on the lower stream of a river, and formed the annular path.
[0003] Although it is desirable from a viewpoint of a deployment of energy to transform thoroughly the heat and pressure energy which a fluid has to the energy of speed in case a nozzle and a bucket are passed for a working fluid and an output is generated, various losses occur according to the factor of the viscosity which the fluid itself has, the gap of the revolution section and the quiescence section, etc. Various methods for loss by the vortex of a different direction from the mainstream generated based on the turn of the flow within a cascade and the so-called secondary flow to also reduce this in order to account for the remarkable rate of the losses in a paragraph especially with low blade length by being generated mainly near the inside-and-outside peripheral wall in one of them are proposed.
[0004] The nozzle of the structure where the nozzle trailing edge was inclined or incurvated to the hoop direction of a turbine also has the composition that what the thing which made the straight-line-like nozzle incline in a hoop direction is incurvated for a RIN nozzle by one of them, and incurvated the nozzle to the hoop direction is shown in a compound RIN nozzle or a bow nozzle, a call, <u>drawing 16</u> , and <u>drawing 17</u> . <u>Drawing 16</u> is drawing having shown the example, and looks at a nozzle from a shaft-orientations lower stream of a river. With the RIN nozzle (a) made to incline so that the intrados side of inner circle wall 20R shown in <u>drawing 16</u> (a) and the nozzle 10 arranged among peripheral-wall 20T may make inner circle wall 20R and acute-angle thetaR Since it has the operation which moves the flow which flows out a trailing edge 12 to the inner circle wall 20R side, while carrying out acceleration rectification of the flow near inner circle wall 20R, a wall surface boundary layer tends to be made thin, and it is going to reduce secondary flow loss of this near. Moreover, <u>drawing 16</u> (b) shows the RIN nozzle made to incline so that the intrados side of a nozzle 10 may make peripheral-wall 20T and acute-angle thetaT, and in order to move the flow which flows out a trailing edge 12 to the peripheral-wall 20T side, it is effective in reducing the secondary flow of the peripheral-wall 20T neighborhood. Furthermore, <u>drawing 16</u> (c) incurvates a nozzle 10 to a hoop direction so that it may be on an intrados side to a convex. Since it has the operation which shows inner circle wall 20R, peripheral-wall 20T, and the compound RIN nozzle that makes an acute angle, respectively, is made to move the flow which flows out the nozzle trailing edge 12 to a wall side in both by the side of inner circle wall 20R and peripheral-wall 20T, and is forced, It has the effect of reducing the secondary flow loss near

inner circle wall 20R and both the wall surfaces of peripheral-wall 20T.
[0005] Moreover, the thing which made the nozzle incline in shaft orientations in the field (for a meridian plane to be called hereafter) which includes a turbine shaft independently is called the skew nozzle, and these examples are indicated to be these to drawing 17 . Since the nozzle trailing edge 12 of the nozzle 10 arranged between inner circle wall 20 R and peripheral-wall 20 T has the operation which shows the skew nozzle which made incline so that inner circle wall 20R and acute-angle alpha R may make, make move the flow which flows out a trailing edge 12 to the inner circle wall 20 R side, and carries out the acceleration rectification of the flow near inner circle wall 20 R, drawing 17 (a) has the effect reduce the secondary flow loss near the inner circle wall 20 R. Moreover, drawing 17 (b) shows the skew nozzle made to incline so that the nozzle trailing edge 12 may make peripheral-wall 20T and acute-angle alphaT, moves the flow which flows out a trailing edge 12 to the peripheral-wall 20T side, and since it has the operation which carries out acceleration rectification of the flow of the peripheral-wall 20T neighborhood, it has the effect reduce secondary flow loss about peripheral-wall 20T.
[0006] The effect of raising paragraph effectiveness by the experiment in a trial turbine etc. is accepted, and a RIN nozzle which was explained above, the compound RIN nozzle, and the skew nozzle are applied to the actual axial flow steam turbine and the gas turbine.
[0007]
[Problem(s) to be Solved by the Invention] However, when using a RIN nozzle, an above-mentioned compound RIN nozzle, or an above-mentioned skew nozzle for a turbine paragraph, there were the following troubles. This situation is explained using drawing 17 and drawing 18 . Drawing 18 (a) is a cross section when including the RIN nozzle shown in drawing 16 (a) in a turbine. The nozzle of this configuration arranges two or more nozzles 10 in the interior of the annular path formed of the field which faces nozzle diaphragm inner-ring-of-spiral-wound-gasket 21R and the path section 1 of the fluid of outer-ring-of-spiral-wound-gasket 21T, i.e., inner circle wall 20R, and peripheral-wall 20T in the shape of a train in a hoop direction. The bucket 41 implanted in the lower stream of a river of a nozzle 10 in the shape of a train around the turbine rotor 40 is arranged. And a nozzle 10 gives flow 2R which goes to a wall surface to the fluid which flows the nozzle trailing edge 12 into the inner circle wall 20R side, rectifies by moving a flow to inner circle wall 20R approach, and acquires the loss reduction effect. For this reason, although it is the same as that of a general nozzle that the peripheral-wall sides 20R and 20T need to exist continuously while an annular flow way is constituted from the nozzle leading edge 11 in the shaft-orientations location to a trailing edge 12 The duty of inner circle wall 20R which responds to a flow in the field which flow 2R which goes to a wall surface produces, and a fluid moves to a wall surface, and is furthermore held in passage with a RIN nozzle is important. It is required to install the wall surface from nozzle trailing edge inner circumference edge 12R continuously to a lower stream of a river to some extent, when demonstrating the function of a RIN nozzle. However, with the RIN nozzle usually used, the shaft-orientations distance from a trailing-edge 12R lower stream of a river to inner circle wall down-stream edge 22R is short like drawing 18 (a) in many cases. In this case, since the flow has the radial-velocity component which still goes to a wall surface also in inner circle wall down-stream edge 22R, The fluid which flow 5R which goes on the direct lower stream of a river of inner circle wall down-stream edge 22R to the method of the outside of a path occurs, and should generate an output effectively once flows into the space besides a turbine paragraph. As a result of exercising flowing in a path again in the bucket 41 upstream etc., turbulence is produced with the flow near a wall surface, and the situation where the effect of an original RIN nozzle is not acquired is caused. In the peripheral-wall 20T side of another side, since a flow does not have the migration by the side of a wall like 2T, the peripheral wall of a trailing-edge lower stream of a river does not need to be installed for a long time by the inner circle wall. Moreover, when long beyond the need, in order for the boundary layer produced on a wall surface with the low-speed fluid of peripheral-wall 20T which flows near to make the increase of thickness, and friction loss increase, it becomes the cause by which this also enlarges aerodynamic loss, very much. Moreover, if inner circle wall 20R is also long beyond the need, the increment in the same friction loss will be caused.
[0008] This situation has the same nozzle aerofoil venter side as shown in drawing 16 (b) on peripheral-wall 20T of the RIN nozzle which makes a peripheral face and an acute angle. As shown in drawing 18 (b), when peripheral-wall 20T are too brief on trailing-edge 12T lower stream of a river of a periphery, flow 5T which

move a fluid to the method of a path outside according to an operation of flow 2T which move to a wall surface on peripheral-wall down-stream edge 22T lower stream of a river arise, and it becomes the cause of paragraph loss.
[0009] furthermore, with the compound RIN nozzle which incurvated the hoop direction so that it might become a convex to a venter, the nozzle 10 shown in drawing 16 (c) Since the flows 2R and 2T which move to a wall surface in inner circle wall 20R and the both sides of peripheral-wall 20T occur as shown in drawing 18 (c), when the length of the wall surface of the lower stream of a river of a trailing edge is unsuitable, loss of the turbine paragraph by flows 5R and 5T increases, and it becomes the cause which lowers effectiveness.
[0010] moreover, when flow 2R which move to a wall surface similarly when the length of inner circle wall 22R be unsuitable have a radial velocity component also on the direct lower stream of a river of inner circle wall down-stream edge 22R also with the skew nozzle for which the nozzle trailing edge 12 as showed in drawing 17 (a), and an inner circle wall make an acute angle, paragraph loss arise, or when peripheral wall 22T be too long, it become the cause which a boundary layer progress near a peripheral wall and lower effectiveness.
[0011] For the same reason, the nozzle trailing edge and peripheral wall like drawing 17 (b) need to make suitable length the length of an inside-and-outside peripheral wall also about the skew nozzle which makes an acute angle.
[0012] This invention removes the defect of the conventional axial flow turbine nozzle shown above, and aims at offering the axial flow turbine nozzle and axial-flow turbine which may improve turbine paragraph effectiveness.
[0013]
[Means for Solving the Problem] In order to solve an above-mentioned technical problem, it sets to invention given in claims 1 and 2. Two or more nozzles are arranged in a hoop direction in an annular path formed as an inner circle wall and a peripheral wall, respectively in an annular nozzle diaphragm inner ring of spiral wound gasket and an annular outer ring of spiral wound gasket. In a thing which made a nozzle incline in a hoop direction of a turbine so that at least one side of a nozzle trailing edge of this nozzle, an inner circle wall or a peripheral wall, and an angle to make may serve as an acute angle It was characterized by forming shaft-orientations distance from a near nozzle trailing edge edge used as this acute angle to a wall surface down-stream edge in optimal length. In an axial flow turbine nozzle of this configuration, a flow in which a nozzle aerofoil venter side and a wall surface have the velocity component of the direction of a medial axis of a turbine produced in a side which makes an acute angle, or the direction of a periphery can be held by wall surface, and an axial flow turbine nozzle in which effectiveness of a turbine paragraph is raised and it deals can be offered.
[0014] It sets [claim 3] to a publication at invention. An annular nozzle diaphragm inner ring of spiral wound gasket and an annular outer ring of spiral wound gasket, respectively An inner circle wall, In a thing which made a nozzle aerofoil incline in shaft orientations of a turbine so that two or more nozzles may be arranged in a hoop direction in an annular path formed as a peripheral wall and either [at least] a nozzle trailing edge, said inner circle wall or a peripheral wall may make an acute angle on a meridian plane It was characterized by determining that the length of a wall surface will make the optimal shaft-orientations distance from a near nozzle trailing edge edge used as this acute angle to a wall surface down-stream edge. Also in what it set [what] to a meridian plane, and inclines or incurvated a nozzle aerofoil to shaft orientations of a turbine by this configuration, a flow with a component of the direction of a medial axis of a turbine in which a fluid flowing out has a nozzle trailing edge, or the direction of a periphery can be held by wall surface, and effectiveness of a turbine paragraph can be improved.
[0015]
[Embodiment of the Invention] The gestalt of operation of the 1st of the axial flow turbine nozzle concerning this invention is explained based on drawing 5 from drawing 1 below. Drawing 1 is the cross section of the axial-flow turbine concerning the gestalt of operation of the 1st of this invention. The axial flow turbine nozzle concerning this operation gestalt also arranges two or more nozzles 10 in the interior of the annular path formed like the conventional axial flow turbine nozzle of the field which faces annular nozzle diaphragm inner-ring-of-spiral-wound-gasket 21R and the path section 1 of the fluid of outer-ring-of-

spiral-wound-gasket 21T, i.e., inner circle wall 20R, and peripheral-wall 20T in the shape of a train in a hoop direction. The bucket 41 implanted in the lower stream of a river of a nozzle 10 in the shape of a train around the turbine rotor 40 is arranged, a turbine paragraph is formed with the cascade of a nozzle 10, it rotates in response to the energy of the fluid which flows out of a nozzle at high speed, and this bucket 41 generates an output. Drawing 2 is drawing which looked at the nozzle 10 given in drawing 1 from the downstream. That is, the nozzle trailing edge 12 has dip in a hoop direction in order to reduce secondary flow loss, and the nozzle 10 is constituted so that the angle with tangent 23of inner circle wall 20R R to make may be set to acute-angle thetaR in nozzle trailing edge inner circumference edge 12R. Drawing 3 is drawing which developed the cascade of a nozzle 10 to the hoop direction on inner circle wall 20R.
[0016] Moreover, it is formation ****** more greatly than the shaft-orientations distance LT from nozzle trailing edge periphery edge 12T [in / for the shaft-orientations distance LR from nozzle trailing edge inner circumference edge 12R in inner circle wall 20R to inner circle wall down-stream edge 22R / a periphery] to peripheral-wall down-stream edge 22T.
[0017] And it is [0018] when shaft-orientations distance from SR and nozzle trailing edge edge 12R of inner circumference to wall surface down-stream edge 22R is set to LR for the throat length of the cascade of the nozzle [in / for the angle which looked at the angle which tangent 23of nozzle trailing edge / in the inner circumference of the nozzle 10 of drawing 2 / 12 and inner circle wall 20R in nozzle trailing edge inner circumference edge 12R R makes from shaft orientations here / thetaR (degree) and an inner circle wall] 10.
[Equation 3]

$$0.03(90-\theta_R) \leq L_R / S_R \leq \{0.03(90-\theta_R)+0.5\}$$

It considered as the ******** thing.
[0019] The antecedent basis and operation are explained below. Since the nozzle trailing edge 12 is constituted as mentioned above by the nozzle of this gestalt with dip at the inner circle wall 20R side in the hoop direction so that the angle with inner circle wall 20R to make may become at acute-angle thetaR, Flow 2R to which the fluid had the velocity compornent of the sense within radial in the fluid by the side of inner circle wall 20R in the nozzle trailing edge edge 12 neighborhood which flows into a hoop direction with a big velocity compornent occurs, and a flow moves to the inner circle wall 20R side from path section central approach. As shown previously, the length of inner circle wall 20R installed in the lower stream of a river of nozzle trailing edge inner circumference edge 12R with the conventional nozzle of drawing 18 (a) is brief, a flow is extruded out of a path and loss occurs in process of joining again etc. However, in the nozzle of this gestalt, since inner circle wall 20R of sufficient length for the lower stream of a river of nozzle trailing edge inner circumference edge 12R is installed, inner circle wall 20R can hold flow 2R which goes to inner circle wall 20R from path section central approach, and it can prevent that a fluid flows out out of a path. Furthermore, since it does not generate, therefore a flow does not move to the peripheral-wall 20T side, the flow which goes to peripheral-wall 20T from path section central approach since it does not incline in the direction in which the nozzle trailing edge 12 makes peripheral-wall 20T and an acute angle to the peripheral-wall 20T side of another side does not need to install a wall surface in the lower stream of a river of nozzle trailing edge periphery edge 12T for a long time in peripheral-wall 20T. Since buildup of a wall surface boundary layer is brought about and loss is made to increase when LT of peripheral-wall 20T is long, as for peripheral-wall 20T, it is desirable that it is shorter than LR of inner circle wall 20R.
[0020] Angle thetaR to which tangent 23of inner circle wall 20R in nozzle trailing edge 12 and nozzle trailing edge inner circumference edge 12R R makes drawing 4 in the inner circumference of a nozzle 10, It is what analyzed the relation of change of the paragraph loss zeta at the time of changing shaft-orientations length LR of a wall surface which results in inner circle wall down-stream edge 22R from a nozzle trailing edge inner circumference edge 12R lower stream of a river by the viscous flow count technique of three dimensions. a horizontal axis -- the ratio of length SR of the throat of the cascade of this LR and a nozzle 10 -- the amount zeta of paragraph losses and the parameter of the value of LR/SR and an axis of ordinate are angle thetaR. This drawing shows that LR/SR from which loss serves as min in ** theta exists. This is for loss occurring at a wall surface down-stream edge for the reason mentioned above when LR/SR was small, the boundary layer on a wall surface becoming thick if a wall surface is superfluously long at one side, and

making loss increase. Moreover, since flow 2R which goes to an inner circle wall side from the sense within radial, i.e., path section central approach, continues having the velocity compornent which goes to the inner circle wall 20R side by becoming strong even after flowing out a nozzle trailing edge so that angle thetaR of a trailing edge and an inner circle wall in a nozzle inner circumference edge is small, it is necessary to install inner circle wall 20R for a long time by shaft orientations for lessening loss. It is drawing 5 which read and illustrated the range of LR/SR which makes loss the level according to min or it when thetaR changes from drawing 4 . It is [0021] when this range is expressed with a formula.
[Equation 4]

$$0.03(90-\theta_R) \leq L_R / S_R \leq \{0.03(90-\theta_R)+0.5\}$$

It becomes.
[0022] In the equipment of this gestalt, the length of the trailing-edge lower stream of a river fills [in addition] a top type about inner circle wall 20R which a flow moves to a wall side. The length of peripheral-wall 20T and by constituting so that it may become shorter than the length of inner circle wall 20R Loss resulting from flow 2R which goes to the inner circle wall 20R side from path section central approach is reduced, and further, since loss by development of the boundary layer by the side of a peripheral wall can also be reduced, the axial flow turbine nozzle and axial-flow turbine which improve paragraph effectiveness can be offered.
[0023] Next, the gestalt of operation of the 2nd of this invention is explained using drawing 8 from drawing 6 . The agreement same about drawing 3 and the equivalent section is attached from above-mentioned drawing 1 , and detailed explanation is omitted. Drawing 6 is the cross section of the axial-flow turbine which applied this operation gestalt. Drawing 7 is drawing which looked at the nozzle 10 given in drawing 6 from the downstream, and drawing 8 is drawing which developed the cascade of a nozzle 10 to the hoop direction on peripheral-wall 20 the Tth page.
[0024] In the gestalt of operation of the 2nd of this invention, a trailing edge 12 has dip in a hoop direction in order to reduce secondary flow loss, and the nozzle 10 is constituted so that the angle of tangent 23T of peripheral-wall 20T to make may be set to acute-angle thetaT in trailing-edge edge 12T of a periphery.
[0025] Moreover, shaft-orientations distance LT from nozzle trailing edge periphery edge 12T to peripheral-wall down-stream edge 22T is made larger than the shaft-orientations distance LR from nozzle trailing edge inner circumference edge 12R to inner circle wall down-stream edge 22R.
[0026] And it is [0027] when shaft-orientations distance from ST and nozzle trailing edge periphery edge 12T to peripheral-wall down-stream edge 22T is set to LT for the throat length of the cascade of the nozzle trailing edge 12 in the periphery of the nozzle 10 of drawing 7 , and the nozzle [angle / which looked at the angle which tangent 23T of peripheral-wall 20T in nozzle trailing edge periphery edge 12T make from shaft orientations] 10 on thetaT (degree) and a peripheral wall here.
[Equation 5]

$$0.03(90-\theta_T) \leq L_T / S_T \leq \{0.03(90-\theta_T)+0.5\}$$

It considered as the ******** thing.
[0028] An operation of the gestalt of the 2nd operation is explained below. In the nozzle of the gestalt of this operation, since the trailing edge 12 makes the hoop direction have inclined in the peripheral-wall 20T side so that the angle of peripheral-wall 20T to make may become at acute-angle thetaT, flow 2T of the radial outwardness in the peripheral-wall 20T side occur, and the operation which moves a flow to a peripheral-wall side arises. Since peripheral-wall 20T of sufficient length for the lower stream of a river of nozzle trailing edge periphery edge 12T are installed in the nozzle of this operation gestalt at this time, peripheral-wall 20T can hold flow 2T which go to peripheral-wall 20T from path section central approach, and it can prevent that a fluid flows out out of a path. Moreover, since a flow does not move to the inner circle wall 20R side in inner circle wall 20R of another side, it is not necessary to install the wall surface of the lower stream of a river of nozzle trailing edge inner circumference edge 12R for a long time. Since buildup of a wall surface boundary layer is brought about and loss is rather increased when too long, as for inner circle wall 20R, it is desirable that it is shorter than peripheral-wall 20T.
[0029] Furthermore, although drawing 4 and drawing 5 which were shown previously were explained

[******] when it applied to inner circle wall 20R of a nozzle, the theory does not ask an inside-and-outside peripheral wall, but can apply it also about peripheral-wall 20T like this operation gestalt. Therefore, the paragraph loss zeta can be reduced by making LT/ST into the range of a top type. Thus, according to the configuration of this operation gestalt, loss resulting from flow 2T which go to the peripheral-wall 20T side from path section central approach is reduced, and it becomes possible further by reducing loss by development of the boundary layer by the side of inner circle wall 20R to improve the effectiveness of a turbine paragraph.

[0030] Next, the gestalt of operation of the 3rd of this invention is explained using drawing 9 and drawing 10 . Drawing 9 is the cross section of an axial-flow turbine, and drawing 10 is drawing which looked at the nozzle given in drawing 9 from the downstream. In addition, the agreement same about the configuration of drawing 8 and the equivalent section is attached from drawing 1, and detailed explanation is omitted. As shown in drawing 10 , in the gestalt of this operation, a hoop direction is incurvated so that it may become a convex to a venter about a nozzle 10, and angle thetaR to make and tangents [of the tangents 13R and 13T of the nozzle trailing edge 12, an inner circle wall, and peripheral walls 20R and 20T]R [23] and 23T and thetaT are used as the acute angle in both nozzle trailing edge inner circumference edge 12R of a nozzle 10, and nozzle trailing edge periphery edge 12T, In this case, the shaft-orientations distance LR and LT from the nozzle trailing edge inner circumference edge and the periphery edges 12R and 12T in both wall surfaces to an inner circle wall and the peripheral-wall down-stream edges 22R and 22T constitutes so that the relation of the formula which can be found from drawing 4 may be filled. That is, it is [0031] when shaft-orientations distance from SR and nozzle trailing edge inner circumference edge 12R to inner circle wall down-stream edge 22R is set to LR for the throat [angle / which looked at the angle which tangent 23of tangent 13R / of the nozzle trailing edge 12 / and inner circle wall 20R R makes to the inner circle wall 20R side from shaft orientations] length on thetaR and inner circle wall 20R of the cascade of a nozzle 10.

[Equation 6]

$$0.03(90-\theta_R) \leqq L_R / S_R \leqq \{0.03(90-\theta_R)+0.5\}$$

It constitutes so that it may become. On the other hand, it is [0032] when shaft-orientations distance from ST and nozzle trailing edge periphery edge 12T to peripheral-wall down-stream edge 22T is set to LT for the throat [angle / which looked at the angle which tangent 23T of tangent 13T of the nozzle trailing edge 12 and peripheral-wall 20T make similarly from shaft orientations] length on thetaT and peripheral-wall 20T of the cascade of a nozzle 10 at the peripheral-wall 20T side.

[Equation 7]

$$0.03(90-\theta_T) \leqq L_T / S_T \leqq \{0.03(90-\theta_T)+0.5\}$$

It constitutes so that it may become.

[0033] The operation in the gestalt of this operation is explained below. With the configuration of the curved nozzle 10, outwardness 2R and 2T, i.e., the flows which go to a wall surface, generates a fluid from path section central approach in the inner circle wall 20R side in the nozzle trailing edge 12 neighborhood at the sense within radial, and peripheral-wall 20T side, respectively. By this flow, the operation which moves a flow toward both wall surfaces in use arises. At this time, if the length LR and LT of the wall surface installed in the lower stream of a river of a nozzle trailing edge inner circumference edge and the periphery edges 12R and 12T in each by the side of inner circle wall 20R and peripheral-wall 20T is short, loss will occur in the process in which a flow is extruded out of passage and joins again on a lower stream of a river. Moreover, since buildup of a wall surface boundary layer is caused and loss is made to increase when too long, it is the same as that of the 1st of this invention, and the gestalt of the 2nd operation which should be considered as a respectively proper range. According to the gestalt of this operation, since the wall surface length LR and LT of a trailing-edge lower stream of a river is constituted in the proper range in both by the side of inner circle wall 20R and peripheral-wall 20T, loss is reduced and the effectiveness of a turbine paragraph can be improved.

[0034] Next, the case of the skew nozzle for which the nozzle inclines in shaft orientations in a meridian plane as a gestalt of operation of the 4th of this invention, and a nozzle trailing edge and an inner circle wall make an acute angle within a meridian plane is explained using drawing 11 . In addition, about the

equivalent section, the same agreement is attached with drawing 1 to drawing 10 , and detailed explanation is omitted. In drawing 11 , shaft orientations are made to incline so that the shaft-orientations location of nozzle trailing edge periphery edge 12T may be located in a turbine-shaft lower stream of a river from nozzle trailing edge inner circumference edge 12R, and the nozzle 10 is constituted so that angle alphaR which the trailing-edge line 12 and inner circle wall 20R make may become an acute angle. The feature of the gestalt of this operation is having constituted the shaft-orientations distance LR from nozzle trailing edge inner circumference edge 12R on inner circle wall 20R to inner circle wall down-stream edge 22R in the range in which paragraph loss serves as the minimum level according to angle alphaR which the nozzle trailing edge 12 in a meridian plane and inner circle wall 20R make. That is, it is the value of LR/SR when shaft-orientations distance of nozzle trailing edge inner circumference edge 12R to inner circle wall down-stream edge 22R in SR and inner circle wall 20R is set to LR for the throat [angle / on the meridian plane which the nozzle trailing edge 12 and inner circle wall 20R make] length on alphaR (degree) and inner circle wall 20R of the cascade of a nozzle 10 [0035]
[Equation 8]

$$0.04(90-\alpha_R) \leqq L_R / S_R \leqq \{0.04(90-\alpha_R)+0.5\}$$

It is characterized by making it ******.
[0036] The operation is explained below. in the case of the skew nozzle constitute by shaft orientations with dip , flow 2R which go to inner circle wall 20R from the sense within radial , i.e. , path section central approach , by the inner circle wall 20R side occur so that angle alphaR in the meridian plane which the nozzle trailing edge 12 of a nozzle inner circumference edge make with inner circle wall 20R may become an acute angle like the gestalt of this operation , and the operation which force a flow on inner circle wall 20R arise . If the shaft-orientations distance LR to inner circle wall down-stream edge 22of nozzle trailing edge inner circumference edge 12R to inner circle wall 20R R is short at this time, the flow near the inner circle wall 20R will be extruded out of a path, and aerodynamic loss will occur in process of joining again etc. On the contrary, when inner circle wall 20R is long beyond the need, buildup of a wall surface boundary layer is brought about and loss is made to increase. Therefore, according to alphaR, there is the optimal range in the shaft-orientations distance LR from nozzle trailing edge inner circumference edge 12R to inner circle wall down-stream edge 22R whenever [meridian plane interior angle / which the nozzle trailing edge 12 makes with inner circle wall 20R in nozzle inner circle wall 20R].
[0037] In order to ask for this relation, the paragraph loss zeta at the time of changing shaft-orientations length LR of the nozzle trailing edge 12 in nozzle trailing edge inner circumference edge 12R, angle alphaR in the meridian plane which inner circle wall 20R makes, and inner circle wall 20R of nozzle trailing edge 12 lower stream of a river in inner circle wall 20R is analyzed, and this result is shown in drawing 13 . this drawing -- the ratio of throat length SR of horizontal-axis shaft-orientations length LR and the cascade of a nozzle 10 -- the paragraph loss zeta and the parameter of LR/SR and an axis of ordinate are angle alphaR. From this drawing, LR/SR from which loss serves as min in each alphaR is obtained. When alphaR changes from now on, the thing illustrating the range of LR/SR which makes loss the level according to min or it is drawing 14 . It is [0038] when this is expressed with a formula.
[Equation 9]

$$0.04(90-\alpha_R) \leqq L_R / S_R \leqq \{0.04(90-\alpha_R)+0.5\}$$

It becomes.
[0039] According to the nozzle of the gestalt of this operation which constituted shaft-orientations length LR in this range in inner circle wall 20R, since length LR of inner circle wall 20R of nozzle trailing edge 12 lower stream of a river is constituted in the optimal range in the inner circle wall 20R side, conventionally, the length of inner circle wall 20R can reduce the loss generated according to it having not been the optimal, and, therefore, can improve the effectiveness of a turbine paragraph.
[0040] Next, the gestalt of the 5th operation is explained using drawing 12 . In addition, about the equivalent section, the same agreement is attached with drawing 1 to drawing 11 , and detailed explanation is omitted. The gestalt of this operation is applied to the skew nozzle constituted so that the nozzle trailing edge 12 and angle alphaT in the meridian plane which peripheral-wall 20T make might become an acute

angle, as shown in drawing 12 . the time of setting shaft-orientations distance of peripheral-wall 20T from ST and nozzle trailing edge periphery edge 12T to peripheral-wall down-stream edge 22T to LT for the throat [angle / on the nozzle trailing edge 12 and the meridian plane which peripheral-wall side 20T make] length on alphaT and peripheral-wall 20T of the cascade of a nozzle 10 -- the ratio of the shaft-orientations distance LT and throat length ST -- LT/ST -- [0041]
[Equation 10]
$$0.04(90-\alpha_T) \leqq L_T / S_T \leqq \{0.04(90-\alpha_T)+0.5\}$$

It constitutes in ******.
[0042] The operation is explained below. The gestalt of this operation is applied to the skew nozzle constituted by shaft orientations with dip so that angle alphaT in the meridian plane which the nozzle trailing edge 12 makes with peripheral-wall 20T in nozzle trailing edge periphery edge 12T may become an acute angle. In this case, in the nozzle trailing edge 12 neighborhood a fluid flows out with a big speed, by dip of a trailing edge, flow 2T of the radial outwardness in the peripheral-wall 20T side occur, and the operation which forces a flow on peripheral-wall 20T arises. If the shaft-orientations distance LT of peripheral-wall 20T installed in the lower stream of a river of nozzle trailing edge periphery edge 12T of a nozzle trailing edge to peripheral-wall down-stream edge 22T at this time is short, an about [peripheral-wall 20T] flow will be extruded out of a path, and aerodynamic loss will occur in process of joining again etc. On the contrary, when peripheral-wall 20T are long beyond the need, buildup of a wall surface boundary layer is brought about and loss is made to increase. Therefore, according to alphaT, there is the optimal range in the shaft-orientations distance LT from the lower stream of a river of nozzle trailing edge periphery edge 12T to peripheral-wall down-stream edge 22T whenever [meridian plane interior angle / which a trailing edge makes with an inner circle wall in nozzle inner circumference]. Although the result of having analyzed the paragraph loss zeta at the time of changing the shaft-orientations length of angle alphaR in the child rear face which the trailing edge and wall surface in the nozzle wing tip shown as drawing 13 and drawing 14 make, and the wall surface of a trailing-edge lower stream of a river was applied about the inner circle wall, in a peripheral wall, it is applicable similarly. Therefore, the paragraph loss zeta can be reduced by making LT/ST into the range of a top type also in the gestalt of this operation.
[0043] According to the nozzle constituted like the gestalt of this operation, since wall surface length LT of a trailing-edge lower stream of a river is constituted in the optimal range in the peripheral-wall 20T side, conventionally, peripheral-wall side length can reduce the loss generated according to it having not been the optimal, and, therefore, can improve the effectiveness of a turbine paragraph.
[0044] The gestalt of the 6th operation is explained using drawing 15 . In addition, the agreement same about the equivalent section as drawing 1 to drawing 14 is attached, and detailed explanation is omitted. A nozzle 10 applies the gestalt of this operation to the skew nozzle which curved to shaft orientations. That is, angle alphaR in the meridian plane which the tangents 13R and 13T of the nozzle trailing edge 12 make with peripheral walls 20R and 20T inside in both nozzle trailing edge inner circumference edge 12R and periphery edge 12T, and alphaT are applied to the skew nozzle constituted acutely, respectively. and the ratio of the distance LR and LT of the shaft orientations from a nozzle trailing edge inner circumference edge and the periphery edges 12R and 12T to inner circumference and the peripheral-wall down-stream edges 22R and 22T, and the throat length SR and ST of the cascade of the nozzle 10 in inner circumference and peripheral walls 20R and 20T -- LR/SR and LT/ST -- both by the side of inner circumference and a periphery -- setting -- these subscripts R and T -- omitting -- [0045]
[Equation 11]
$$0.04(90-\alpha) \leqq L / S \leqq \{0.04(90-\alpha)+0.5\}$$

It constitutes so that it may become.
[0046] in the gestalt of this operation, although the operation which an inner circumference and periphery side is alike, respectively, sets, and forces a flow on a wall surface near a nozzle trailing edge arises, the respectively optimal range for the above 4th and the length of the wall surface installed in the lower stream of a river of the nozzle trailing edge 12 like the gestalt of the 5th operation exists. With the gestalt of this operation, by making into this range the length of the inside-and-outside peripheral walls 20R and 20T

installed in the lower stream of a river of the nozzle trailing edge 12, the loss which had occurred conventionally can be reduced and, therefore, the effectiveness of a turbine paragraph can be improved.
[0047]
[Effect of the Invention] As explained above, it sets to the axial flow turbine nozzle of this invention. In what was formed so that a turbine nozzle might make an acute angle in the configuration in a wall surface, a hoop direction, or a meridian plane, in order to prevent loss by the secondary flow In case a turbine-nozzle trailing edge is flowed out by making wall surface length the optimal, by holding a flow with a big speed with the velocity compornent of the direction of a medial axis of a turbine, or the direction of a periphery in passage, paragraph loss of a turbine can be reduced and, therefore, the effectiveness of a turbine can be raised.

[Translation done.]

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] In order that this invention may control the secondary flow which generates a side-attachment-wall side [which was arranged near the aerofoil which operates in the flow of uniform flow], and surface-area top in the progressing boundary layer, may reduce secondary flow loss and may raise internal efficiency, it uses as the three-dimensions aerofoil which changed the configuration in three dimensions, and relates to buckets, such as a steam turbine or a gas turbine, and the high-performance aerofoil which reaches or used as a stationary blade.
[0002]
[Description of the Prior Art] With the high performance reactionary aerofoils, reduction of secondary flow loss according to a three-dimensions design method in a bucket and a stationary blade is achieved by reaction control. However, in the fabrication by the three-dimensions design method of the conventional aerofoil, in respect of the side attachment wall which approaches the chip and the base of an outer-diameter edge among aerofoils, the secondary flow generated the side-attachment-wall side top in the progressing boundary layer, and this flowed out of the trailing edge of an aerofoil as an eddy, and had generated secondary flow loss. However, by leaning the configuration of the height direction of an aerofoil from a radial line, a flow is forced on a side-attachment-wall side, development of the eddy in the side-attachment-wall side close to a chip and the base is pressed down, the eddy which flows out of the trailing edge of an aerofoil is reduced, and the thing aiming at reduction of secondary flow loss has recently been put in practical use. Thus, the high performance aerofoil which made the configuration of the height direction of an aerofoil incline from a radial direction is usually called the perfect three-dimensions aerofoil.
[0003] Drawing 3 is drawing which looked at the high performance aerofoil which was mentioned above, and which was manufactured by the conventional three-dimensions design method from the method Kogo style side of a shaft, and is the conceptual diagram showing the flows 05 and 06 which flow out of the inside of an aerofoil 01 with the configuration of a trailing edge 02. The blade length direction with the high performance aerofoils which formed the aerofoil 01 formed in radial direction R in the shape of another straight line so that he can understand from the configuration of a trailing edge 02 shown in drawing By the fabrication of aerofoil 01 configuration by the three-dimensions design method, generate a surface-area top in the progressing boundary layer. Although reduction of loss by a secondary flow etc. can be aimed at, produce the chip wall surface [which counters an outer-diameter edge among aerofoils 01, and is arranged] 03, and base wall surface 04 top with the flow in the progressing boundary layer. The secondary flow loss which cannot reduce generating of a secondary flow, but produces by the secondary flow, and is produced by flowing out of a trailing edge 02 as an eddy was not able to be reduced.
[0004] A high performance aerofoil in drawing seen from the method Kogo style side of a shaft For this reason, the configuration of trailing edge 02', As shown in drawing 6 which is the perspective diagram of drawing 5 which is the perspective diagram of the high performance aerofoil shown in drawing 4 which shows the flows 05 and 011 which flow out of the inside of aerofoil 01', and drawing 4 , and the high performance aerofoil arranged between the chip wall surface 03 and the base wall surface 04 The blade length direction receives radial direction R. In respect of [about 04] a chip 03 and the base While making the configuration of the blade length direction incline mutually in an opposite direction, the high

performance aerofoil called a perfect three-dimensions aerofoil in which the curve of the arc shape which continued in the blade length direction was formed is manufactured and used increasingly.

[0005] Moreover, this kind of high performance aerofoil may also be called a SUKYUDO (Skewed) aerofoil or a bow (Bow) aerofoil. Furthermore, with such perfect three-dimensions aerofoils, as shown in drawing 5 and drawing 6 , to radial direction R, the bow of the arc shape prepared in the aerofoil 02 height direction makes the center section of the blade length direction the amount of the maximum projection also with the aerofoil entrance section 07 near the first transition, and the aerofoil outlet section 08 near trailing-edge 02', and it is formed so that it may be made to curve to a **** 09 side. That is, as shown in drawing 5 , while applying only the amount shown in the blade length direction by view length from first transition to trailing-edge 02' and incurvating it to a venter 010 to radial direction R, he is trying to form a bond segment for between the tip side from which the tilt angle to radial direction R becomes reverse mutually, and base sides by the smooth curve.

[0006] Since the center section of blade length is incurvated to the venter 09 at the arc shape, with such conventional perfect Miyoshi aerofoils to the chip wall surface 03 and about 04 base wall surface backside 010 The other forcing flow 011 occurs, respectively on these wall surfaces 03 and 04 as shown in drawing 4 by the view. Reduction of secondary flow loss can be aimed at by reducing the cross flow which the pressure on the chip wall surface 03 and the base wall surface 04 is raised, and progresses on these wall surfaces 03 and 04 and which is generated in a boundary layer.

[0007] However, the thing for which the chip wall surface 03 and about 04 base wall surface pressure is raised in this way A pressure gradient will arise from these 03 or about 04 wall surfaces to blade length direction and so-called radial direction R. By this pressure gradient The flow of the mainstream 05 to radial direction R of a secondary flow generated in the boundary layer of these wall surfaces 03 and 04 which it will wind, a riser will increase, and this secondary flow winds, and passes through the inside of aerofoil 01' by the riser is disturbed, floating loss is enlarged, and there is nonconformity that paragraph effectiveness falls.

[0008]

[Problem(s) to be Solved by the Invention] This invention raises the pressure the conventional high performance aerofoil especially a chip wall surface, and near the base wall surface. The property of the conventional perfect three-dimensions aerofoil of reducing the cross flow generated within the boundary layer which progresses on these wall surfaces, and having reduced secondary flow loss While making it maintain then, in order for the secondary flow which is generated with the conventional perfect three-dimensions aerofoils and which is generated by the pressure gradient formed in the blade length direction from on a chip wall surface and a base wall surface to wind and to prevent decline in the effectiveness by the riser, Let it be a technical problem to offer the high performance aerofoil which lessened decline in paragraph effectiveness by controlling the magnitude of the pressure gradient formed towards a blade length center section from this chip wall surface and a base wall, and a secondary flow's winding, and reducing a riser in the aerofoil outlet section.

[0009]

[Means for Solving the Problem] For this reason, a high performance aerofoil of this invention was made into the following means. A chip wall surface arranged by three-dimensions design method near the chip of an aerofoil which operates in a flow of uniform flow, And it sets on high performance aerofoils which a pressure near [which was arranged near the base of an aerofoil] the base wall surface is raised, are made to reduce a cross flow in a boundary layer which progresses on these wall surfaces, and reduced secondary flow loss and which were manufactured by perfect three-dimensions aerofoil. While the aerofoil entrance section incurvated a venter to an arc shape in the blade length center section, the aerofoil outlet section made an aerofoil profile the shape of a profile which incurvated reverse to a backside in the blade length center section at an arc shape.

[0010] With an above-mentioned means, a high performance aerofoil of this invention can reduce a secondary flow in a boundary layer [in / like the conventional perfect three-dimensions aerofoil / by bow of an arc shape to a venter of the aerofoil entrance section / a chip and a base wall surface, and a surface area of an outer-diameter edge in an aerofoil], can press down development of an eddy generated from these fields, can reduce strength of an eddy which flows out of a trailing edge of an aerofoil, and can reduce

secondary flow loss.
[0011] Moreover, from in addition, a thing which the aerofoil outlet section carried out to a bow of an arc shape which projects to a backside of reverse with a bow of an arc shape of the aerofoil entrance section Forced a flow on a wall surface side in the aerofoil entrance section, and the failure of pressure had arisen from a chip wall surface and a base wall surface towards a blade length center section. A pressure gradient of a radial direction is missing from the aerofoil outlet section from the aerofoil entrance section, and becomes small gradually. It will wind, a riser will be reduced, secondary flow loss will be reduced, mainstream turbulence which passes through the inside of a radial aerofoil of a secondary flow on the back of an aerofoil generated with the conventional perfect three-dimensions aerofoils can decrease, and paragraph effectiveness can be raised.
[0012]
[Embodiment of the Invention] Hereafter, one gestalt of operation of the high performance aerofoil of this invention is explained based on a drawing. Drawing 1 is drawing showing the 1st gestalt of operation of the high performance aerofoil of this invention, and a perspective diagram to show the bow configuration of an arc shape established in the blade length direction and drawing 2 are perspective diagrams to show what has arranged the high performance aerofoil shown in drawing 1 between a chip wall surface and a base wall surface.
[0013] As shown in drawing 1 , in the aerofoil entrance section 2 of an aerofoil 1, from the tip side and base side, the amount of projection by the side of a belly 4 is enlarged gradually, and the configuration which curved to the arc shape of the shape of a curve made to project most to a belly 4 side in the blade length center section is formed in the blade length direction. Namely, in the first transition 3 which is the maximum upstream edge of the aerofoil entrance section 2, the bow of the arc shape in which only the magnitude shown by the length of a view projected is formed in the belly 4 direction shown by the view from radial direction R.
[0014] Moreover, in the aerofoil outlet section 6 of an aerofoil 1, the amount of projection is gradually enlarged from a tip side and base side to a backside 5, and the bow of the arc shape of the shape of a curve which becomes the amount of the maximum projection in the blade length center section is formed. Namely, in the trailing edge 7 which is the lowest style edge of the aerofoil outlet section 6, the bow of the arc shape which made only the magnitude shown by the length of a view project is formed in the backside 5 direction shown by the view from radial direction R. Moreover, it is made the ** kana curve which does not have a break point even if it turns to the aerofoil outlet section 6 from the aerofoil entrance section 2, and the bow of the arc shape prepared in these blade length directions is **************.
[0015] Since the high performance aerofoil of this invention is constituted as mentioned above, it is set in the aerofoil entrance section 2 with the deflection of the arc shape prepared in the radial direction of the aerofoil entrance section 2. On the chip wall surface 8 prepared in the tip side of the aerofoil 1 shown in drawing 2 , and the base wall surface 9 prepared in the base side of an aerofoil 1, the other side, The forcing flow 011 shown in drawing 4 and the same flow occur, and the pressure on the chip wall surface 8 and the base wall surface 9 is raised. The secondary flow in these wall surfaces 8 and the boundary layer which progresses on nine is reduced by these pressure buildups, development of the eddy generated from each of wall surfaces 8 and 9 can be pressed down, the strength of the eddy which flows out of the trailing edge 7 of an aerofoil 1 can be reduced, and secondary flow loss can be reduced like the conventional perfect Miyoshi aerofoil.
[0016] From the aerofoil outlet section 6 having made it the bow of the arc shape formed in the aerofoil entrance section 2, and the bow of the arc shape which formed the convex in the backside 5 of reverse, moreover, in the aerofoil entrance section 2 Force a flow on the chip wall surface 8 and base wall surface 9 side, and the failure of pressure arises from the chip wall surface 8 and the base wall surface 9 towards a blade length center section. It becomes small gradually by change of the configuration of the segment applied to the aerofoil outlet section 6 from the aerofoil entrance section 2 where the pressure gradient of a radial direction changes from the configuration of the segment which projected in the venter 4 to the configuration of the segment which projected in the backside, and ****** becomes is not less in the aerofoil outlet section 6. By dissipation of the pressure gradient reduced towards a blade length center section from on this chip wall surface 8 and the base wall surface 9, the turbulence of the rectification which would wind,

and would reduce the riser, and secondary flow loss will reduce, and had been generated with the conventional perfect three-dimensions aerofoils and which passes through the inside of the radial aerofoil of the secondary flow in the aerofoil 1 back generated with the conventional perfect three-dimensions aerofoils can decrease, and paragraph effectiveness can be raised.

[0017]

[Effect of the Invention] As explained above, by the configuration which is shown in a claim according to the high performance aerofoil which becomes this invention It compares with the perfect three-dimensions aerofoil which has improved the high performance aerofoil manufactured by the conventional three-dimensions design method. From on a chip wall surface and a base wall surface, generating of the pressure gradient which changes in the blade length direction, respectively is controlled, the floating loss to radial [accompanying it / of a secondary flow] which it wound, and the riser was also controlled and originated in this secondary flow is reduced sharply, and turbine efficiency can be raised.

[Translation done.]

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the bucket of an axial-flow turbine.
[0002]
[Description of the Prior Art] The bucket of an axial-flow turbine is various. This is because it is determined based on a turbine maker's layout concept so that the bucket of an axial-flow turbine may become what was able to take harmony from on layout of a heat flow rate object and the whole structure, and the flexibility of the design manual is very large.
[0003] a thing given [as latest example among the well-known examples about the conventional technology] in VGB Kraftwerkstech (1988) -- it is -- this -- the design manual of the bucket of an axial-flow turbine -- heat flow rate physical strength study-like -- reinforcement and an oscillation -- what it has opted for from the monograph affair of being dynamic is described.
[0004] Next, drawing 6 - drawing 11 explain the bucket of the conventional axial-flow turbine.
[0005] drawing 6 -- explanatory drawing of the bucket configuration of the axial-flow turbine of the conventional example, and drawing 7 -- the length of a wing of the conventional example -- explanatory drawing of the profile of direction each location -- Explanatory drawing about the configuration of the cascade of the conventional example and drawing 9 drawing 8 Explanatory drawing of the aerofoil inlet angle of the conventional example, and an aerofoil exit angle, Drawing 10 is explanatory drawing of each cascade of the bottom section of the conventional example, and a point, and drawing 11 is explanatory drawing of the profile loss factor of the conventional example. In first transition and 3, a trailing edge and 5 a passage entrance and 7 for a backside and 6 A passage outlet, [1] [a profile and 2] In 8, the trailing edge edge of a venter and 9 a breakaway field and 12 for an elementary stream and 11 The profile section, B -- the cascade shaft-orientations size of the first transition section of an aerofoil, and the trailing-edge section, and S -- a throat size and t -- an aerofoil pitch and W -- a span and betam -- an aerofoil inlet angle and H -- the length of a wing and L -- geometry -- the manager -- in gammam, an aerofoil exit angle and C show angular distance, and theta shows the deflection angle of an aerofoil.
[0006] What took out only two adjoin is shown from the bucket currently installed in the perimeter of the circumference of a turbine shaft by drawing 6 . The profile section 12 which is the passage of a fluid, and the geometry section 13 with a turbine shaft are united, the bucket is formed, and the installation gap of the adjoining bucket is expressed with the aerofoil pitch t.
[0007] drawing 7 -- the length of a wing of a bucket -- the profile 1 of direction each location is shown. Each profile 1 in the bottom section which also included the geometry section 13 with a turbine shaft in (c) of a center section and drawing 7 at (a) of drawing 7 at (b) of a point and drawing 7 is shown, respectively.
[0008] The aerofoil pitch t is large as it goes to a point from the bottom section of a bucket, since a bucket is installed in the shape of a sector from a turbine-shaft center.
[0009] A fundamental item required for a cascade configuration is shown in drawing 8 . That is, the profile 1 is prescribed by a span W, angular distance C, aerofoil inlet angle betam, aerofoil exit angle gammam, etc. Moreover, it has the passage entrance 6 and the passage outlet 7 in the passage between the adjoining profiles 1, i.e., the passage between the cascades which a profile 1 consists of by standing in a row, and the narrowest part of passage is determined as it with the throat size S from the geometric relation between the

trailing edge edge 8 of a venter, and the backside 5 of the adjoining profile 1 which meets it.
[0010] As the configuration of the above profiles and cascades was mentioned above, it is determined from heat flow rate object layout and layout on the strength, and aerofoil inlet angle betam and aerofoil exit angle gammam are determined from on heat flow rate object layout. As shown in drawing 9 , these angles change with locations of the height of an aerofoil, i.e., radial [of a bucket], and have become what was generally in agreement with the angle of the flow direction of the fluid determined from heat flow rate object layout.
[0011] On the other hand, on layout on the strength, the aerofoil cross section which can bear the applied force from a fluid and a centrifugal force is determined. In this case, it is gradually made small as generating stress is as large as the bottom section of a profile, and it is the largest in the bottom section in an airfoil profile product since it becomes small in a point, and it becomes a point. A span W and angular distance C are determined by this layout policy.
[0012] Furthermore, the cascade pitch t is determined that the geometry sections of the bucket connected with a turbine shaft are a reinforcement top and sufficient configuration. Furthermore, the ratio of the throat size S and a pitch t is set up so that the flow rate which passes through between cascades may satisfy a predetermined value.
[0013] The example of a configuration of the profile and cascade which were determined by the above design manuals is shown in drawing 10 . (b of (a) of drawing 10) of the bottom section and drawing 10 is each **** of a point. If both are compared, betam, and t and S are larger than the bottom section at a point, and the deflection angle theta is small. The bucket is constituted so that such a profile 1 may change continuously from the bottom section to a point.
[0014] a profile loss factor becomes a property as shown in drawing 11 by the ratio (=t/C) of the aerofoil pitch t and angular distance C from which aerofoil inlet angle betam as shown in (a) of drawing 10 constitutes a cascade about the small profile 1 -- Ainley etc. -- it is described and it is shown that optimal t/C changes with aerofoil inlet angle betam like the dotted line (minimum value) in drawing 11 .
[0015] In addition, betam in drawing 11 has the relation of 1(betam) > (betam) 2>(betam) 3>(betam) 4, and (betam) is the case of 1= 50 degrees. Therefore, it is applied to the profile of the bottom section shown in (a) of drawing 10 .
[0016] Moreover, the test result about various kinds of cascade configurations is described by Bammert etc., and change of the thickness of a profile and the profile loss property by the difference with aerofoil inlet angle betam and a fluid inlet angle is shown.
[0017] Moreover, aerofoil inlet angle betam and the aerofoil pitch t as shown in (a) of drawing 10 are small, and the design method with which the deflection angle theta is acquired for the comparatively good engine performance about a large cascade is indicated by A.Uenishi:ASME and 71-GT-34.
[0018]
[Problem(s) to be Solved by the Invention] However, aerofoil inlet angle betam as shown in a head side from the center section of the length of a wing at (b) of drawing 10 becomes a factor with big on-the-strength oscillation-constraint when larger than 90 [whenever] in many cases, and unsolved technology is left behind about high-performance-izing of a cascade.
[0019] the cascade configuration with which it is satisfied of the aerofoil inlet angle betam which is a design condition like a heat flow rate object, aerofoil exit angle gammam, and a throat size S in the conventional technology which described this invention until now -- setting -- the length of a wing -- designing so that the conditions on the oscillation on the strength covering the whole satisfy, making it possible to opt for a cascade configuration, and aiming at realizing the cascade configuration of the high performance in the bucket of an axial-flow turbine
[0020]
[Means for Solving the Problem] The above-mentioned object can be attained as follows.
[0021] Namely, this invention is set to a bucket of an axial-flow turbine which has an aerofoil inlet angle formed corresponding to a direction where an elastic fluid flows. Said aerofoil inlet angle a portion of an aerofoil are winged in a range more than whenever [[90+233.4 {0.3-(B-t)/t}]] A pitch of a cascade of a bucket is formed so that (B-t)/t may become the ranges from 0.01 to 0.3 about it, when a cascade shaft-orientations size of t, the first transition section of an aerofoil, and the trailing-edge section is set to B, and the desired end is attained. [0022] Moreover, it sets to a bucket of an axial-flow turbine which has an

aerofoil inlet angle formed corresponding to a direction where an elastic fluid flows. Said aerofoil inlet angle a portion of an aerofoil are winged in a range from whenever [[90+233.4 {0.3-(B-t)/t}]] to 180 degrees A pitch of a cascade of a bucket is formed so that (B-t)/t may become the ranges from 0.01 to 0.3 about it, when a cascade shaft-orientations size of t, the first transition section of an aerofoil, and the trailing-edge section is set to B. [0023] Moreover, when a cascade shaft-orientations size of t, the first transition section of an aerofoil, and the trailing-edge section is set [said aerofoil inlet angle] to B for a pitch of a cascade of betam and a bucket in a bucket of an axial-flow turbine which has an aerofoil inlet angle formed corresponding to a direction where an elastic fluid flows, it is a degree type, [0024], between betam and (B-t)/t. [i.e.,]

[Equation 2] beta -- m -- [-- whenever --] -- = -- 90 -- [-- whenever --] -- + -- 233.4 -- {-- 0.3 - (B-t) -- /-- t --} -- [-- whenever --] .... (-- one --) -- relation -- it is -- an aerofoil -- a portion -- (-- B-t --) -- /-- t -- 0.01 -- from -- 0.3 -- up to -- a range -- becoming -- as -- forming . [0025]

[Function] This invention examines the existence of optimum conditions to a cascade configuration first using drawing 12 . The example whose aerofoil inlet angle betam is about 90 degrees is shown, drawing 12 is explanatory drawing about the comparison of the example of a cascade configuration, and it is [each length of the aerofoil pitch t and the throat size S of each of (a) of drawing 12 , (b), and (c) is the same, and] the case where angular distance C differs from a span W from the conditions on reinforcement. If (a) of drawing 12 , (b), and (c) are compared, angular distance C and a span W are different, and also the cascade shaft-orientations sizes B of the first transition section of an aerofoil and the trailing-edge section differ.

[0026] That is, at (a) in drawing 12 , t>B and (b) become t<B and it has become t<<B by (c). In this case, floating in the passage between cascades will be in the condition that it is shown in drawing 13 . That is, drawing 13 is explanatory drawing of the relation between a cascade configuration and floating, and (a) of drawing 13 , (b), and (c) are the cascade configurations corresponding to (a) of drawing 12 , (b), and (c), respectively.

[0027] At (a) of drawing 13 , the breakaway field 11 occurs in the back side in the passage second half of an elementary stream 9, to becoming the floating condition that the cascade engine performance deteriorates, by (b) of drawing 13 , and (c), it does not generate but a breakaway field will be in a normal floating condition.

[0028] When the superiority or inferiority of the cascade engine performance in (a) of drawing 13 , (b), and (c) are compared, namely, in (a) of drawing 13 There is a defect from which a breakaway field occurs and a normal flow is not acquired, and also in (b) of drawing 13 which is in a normal floating condition, and (c), since a profile is large in (c) and the distance of a surface area and a fluid which touches becomes large as compared with (b), it has the defect in which frictional resistance increases. These things have suggested that there are optimum conditions to the cascade configuration as shown in drawing 12 .

[0029] It is clear that a possibility that the cascade configuration of high performance will be obtained [in / about the cascade configuration of the bucket of an axial-flow turbine / by the above-mentioned examination / 90 degrees or more] has high aerofoil inlet angle betam.

[0030] In this invention, it became possible to use effectively the fluid force which acts on an aerofoil, without spoiling the cascade engine performance by readjusting the cascade shaft-orientations size of an aerofoil pitch, the first transition section of an aerofoil, and the trailing-edge section so that the flow in the passage between cascades may be rationalized.

[0031] That is, if the surface-area pressure distribution in the profile which constitutes a cascade show the operation effect, it will become like drawing 14 . Drawing 14 is explanatory drawing of the relation between a cascade configuration and surface-area pressure distribution, and (a) of drawing 14 , (b), and (c) support (a) of drawing 12 , (b), and (c), respectively.

[0032] In drawing 14 , the product of the area and the span W which are shown with the slash surrounded by the pressure distribution of a venter and a backside is the fluid force which acts on a bucket, and this shows that a difference arises by the cascade configuration.

[0033] Although the area of the portion which shows with a slash in (a) of drawing 14 is large, a span W is small as shown in (a) of drawing 12 . A span W is large as it is shown in (c) of drawing 12 on the other hand, although the area of the portion which shows with a slash in (c) of drawing 14 is small.

[0034] That is, although the fluid force which acts on a bucket is expressed with the area of the portion

shown with this slash, and the product of a span W, it is inadequate to be only the size of this fluid force and to compare the superiority or inferiority of a cascade configuration, and it needs to both avoid generating of the breakaway field seen by (a) of drawing 13 , and buildup of the frictional resistance in (c) of drawing 13 .

[0035] In this invention, when the configuration of a proper cascade as shown in (b) of drawing 13 was able to be performed, high performance-ization of a cascade was attained.
[0036]
[Example] The example of this invention is explained using drawing 1 - drawing 5 .
[0037] Explanatory drawing of a flow [in / in explanatory drawing of each cascade / in / in drawing 1 / the example and the conventional example of this invention / and drawing 2 / the example and the conventional example of this invention] and drawing 3 are explanatory drawings concerning [explanatory drawing of the profile pressure coefficient in the example and the conventional example of this invention and drawing 4 concerning explanatory drawing of the profile loss factor of the example of this invention] the optimal profile configuration of the example of this invention, a venter and 10 show an expansion wave, delta shows the deflection angle of an elementary stream Moreover, it is B-t=**t (B, t both above).
[0038] (a) of drawing 1 is the example of this invention, and (b) of drawing 1 is the conventional example. Here, the case of aerofoil inlet angle betam>90 degree is taken for an example, and both examples are compared and explained.
[0039] By (a) of drawing 1 , and (b), both aerofoil inlet angle betam and the span W are equal, and show the cascade configuration conditions that S/t is almost the same.
[0040] In both examples, the aerofoil pitch t is different from the cascade shaft-orientations size B between the first transition section of an aerofoil, and the trailing-edge section, and it has become t>B in t<B and the conventional example at (a) of drawing 1 which is this example.
[0041] Therefore, even when inlet angle betam which is a heat flow rate object-design condition, and a throat size / aerofoil pitch (= S/t) are made the same, a cascade configuration is different and a result which a difference produces for the cascade engine performance is brought. This becomes clear by comparing the condition of the flow within a cascade.
[0042] Although drawing 2 shows the condition of the flow in the cascade shown in drawing 1 , (a) of drawing 2 and (b) support (a) of drawing 1 , and (b), respectively. In the case of the conditions of t>B shown in (b) of drawing 2 , an elementary stream 9 deviates on the lower stream of a river of the throat size S, the breakaway field 11 occurs, and (a) of drawing 2 reduces the cascade engine performance substantially, although it is the case of t<B which is the configuration conditions of the cascade of this example and an elementary stream 9 is in the smooth condition in alignment with the passage configuration between aerofoils.
[0043] If the pressure distribution of a surface area compare such a floating condition, it will become like drawing 3 , and in the conventional example which is show to be in an acceleration condition with comparatively good venter and backside at (b) of drawing 2 in the case of this example, a pressure declines rapidly by the entrance section of a backside, it becomes an accelerating flow, and a pressure does not decline after that, but a breakaway field occurs, the effect of viscous of a fluid increases, and it is show that profile loss increases.
[0044] The condition of the flow between aerofoils in such a conventional example The field of the expansion wave 10 according [reach acoustic velocity in the portion of the throat size S, have remarkable effect also in a heat flow rate object design condition which becomes a supersonic speed on the lower stream of a river, and] to the relation of the Prandtl Mayer function since the failure of pressure of the trailing edge edge 8 of a venter is rapid (a dashed line shows to drawing 2 .) It becomes large, the deflection angle delta and the breakaway field 11 of an elementary stream which were shown in (b) of drawing 2 become large, and a result to which the cascade engine performance is reduced remarkably is brought.
[0045] That is, high performance-ization is attained by constituting a cascade so that the conditions of t<B in this example shown in drawing 1 may be satisfied. Drawing 4 showed this relation concretely. In drawing 4 , an axis of ordinate is a profile loss factor which shows the engine performance of a cascade, and the horizontal axis shows deltat/t. However, it is deltat=B-t.
[0046] Moreover, although three aerofoil inlet angle betam in drawing, i.e., (betam), the curve of 1, 2

(betam), and (betam) 3, is the case of 1(betam) > (betam) 2>(betam) 3 It is shown that the property of a profile loss factor is different with aerofoil inlet angle betam, and it turns to concave up also in which aerofoil inlet angle betam, and the minimum profile loss factor is so small that aerofoil inlet angle betam is large, and the value of deltat/t has the property which shifts to the smaller one.
[0047] deltat/t in case the minimum profile loss factor serves as the minimum value as the optimum value of deltat/t, 0 [i.e., (deltat/t),] When the relation between 0 and aerofoil inlet angle betam shows, become like drawing 5 and aerofoil inlet angle betam which is the range of this example (deltat/t) Above 90 [whenever] (deltat/t) The value of 0 (deltat/t) becomes small as 0 is in the range of 0.01-0.30 and aerofoil inlet angle betam becomes larger than 90 degrees. Furthermore, specifically, the optimal line of drawing 5 is [0048].
[Equation 3]
betam [whenever] =90 [whenever] +233.4 [{0.3-(B-t)/t} whenever] .... (1)
It is in ******.
[0049] Moreover, in the feature of the profile loss factor shown in drawing 4 , since the augend of the loss factor in the large value of deltat/t decreases so that aerofoil inlet angle betam is large, the applicability of deltat/t becomes large.
[0050] However, in deltat/t<0, since the flow which is not normal occurs in cascade passage as mentioned above, a usable range turns into applicability of drawing 5 . the range of deltat/t where the effect of substantial this invention is acquired as this applicability is set to 0.01-0.3, and the applicability of the aerofoil inlet angle over ** deltat/t is specified in the large range which it is from aerofoil inlet angle betam on the optimal line shown by (1) formula to 180 [whenever].
[0051] In addition, in this example, the cascade engine performance was able to be raised 20 to 40%.
[0052]
[Effect of the Invention] In an axial-flow turbine, by optimizing the cascade shaft-orientations size of an aerofoil pitch, and the first transition of a bucket and a trailing edge, passage between buckets can be improved and, according to this invention, high performance-ization of a cascade can be attained. Especially, this has an effective aerofoil inlet angle in 90 cascade configurations or more, and can raise the cascade engine performance 20 to 40%.

[Translation done.]

5-22290)

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to an axial-flow turbine applicable to various fluid machinery, such as a steam turbine and a gas turbine.
[0002]
[Description of the Prior Art] Generally, as that typical structure is shown in drawing 2 , one paragraph of axial flow fluid machinery, such as a steam turbine and a gas turbine, consists of two or more buckets 2 fixed to the periphery diaphram 3 and the inner circumference diaphram 4 in two or more stationary blades 1, disks 5, and shroud rings 6 by which fixed maintenance was carried out, and consists of so-called many paragraphs with two or more steps of this one paragraph. The high medium-voltage paragraph of a steam turbine and the paragraph of a gas turbine have the small aspect ratio expressed with the ratio of the length of a wing and a chord length, therefore the floating loss resulting from the secondary flow produced by the interaction of the boundary layer which developed into the side attachment wall of the periphery diaphram 3 and the inner circumference diaphram 4, or the surface-area boundary layer of a stationary blade 1 increases them substantially. The mechanism of the secondary flow which develops into such the turbine-cascade side-attachment-wall section is explained using drawing 3 EESUEMUI, a journal OBU TABOMA chenier, and Vol.109 (1987-4). Source: Ore . Py, shear MAANDO Tee El Butler; PURIDI cushion OBU And wall Loss End Secang DAARII Flow Inn AKUSHARU Flow turbine A cascade, TORANZU action The entrance boundary layers 8a, 8b, and 8c which are low energy fluids progress on the side-attachment-wall side 7, and the flows 9a, 9b, and 9c which flow into stationary blades 1a, 1b, and 1c [near the side-attachment-wall side 7] collide with the first transition of stationary blades 1a, 1b, and 1c, and form two horseshoe vortexes.
[0003] These two eddies are divided into the back side horseshoe vortexes 10a, 10b, and 10c and the intrados side horseshoe vortexes 11a, 11b, and 11c. If these eddies enter in the cascade passage of stationary blades 1a, 1b, and 1c, the back side horseshoe vortexes 10a, 10b, and 10c will shift to a lower stream of a river, growing up gradually by development of the stationary-blade back and the boundary layer of a side attachment wall. On the other hand, deviating to a stationary-blade back side so that the passage eddies 12a, 12b, and 12c by which induction is carried out act and it shifts to the downstream by the pressure differential of stationary-blade intrados and the back, like the big secondary flow eddies 13a, 13b, and 13c, it progresses and the intrados side horseshoe vortexes 11a, 11b, and 11c grow. The rate of occupying cascade passage becomes large, so that the aspect ratio expressed with the ratio of the length of a wing of a stationary blade and a chord length is small, and in connection with it, loss of a stationary blade will also increase such secondary flow eddies 13a, 13b, and 13c. Moreover, the secondary flow loss generated in the cascade passage of a stationary blade makes it the additional loss of bringing a big deflection to a stationary-blade efflux angle, changing the fluid inlet angle to the bucket which follows by this from a proper condition to it, and angle of attack loss of a bucket also making it increase to it produced.
[0004] As a reduction measure of secondary flow loss peculiar to such a low aspect ratio paragraph, we proposed the content previously indicated to JP,61-47285,B. This invention is carried out to a configuration which reduces the chord length of a stationary blade gradually as the side attachment wall of an aerofoil head and a blade root is approached from the center section of max, nothing, and the length of a wing in the center section of that length of a wing. And it is characterized by constituting so that a gradual increase may

be carried out as the distance from a stationary-blade outlet edge to a bucket entrance edge serves as min in the center section of said length of a wing and the side attachment wall of an aerofoil head and a blade root is approached from an aerofoil center section (refer to drawing 4 , drawing 5 , drawing 6 , and drawing 7). However, a previous proposal has a dramatically abstract stationary-blade configuration, as mentioned above, and in applying to concrete layout, many technical problems occur. namely, the magnitude of the aspect ratio of a stationary blade -- corresponding -- the length of a wing -- it is important to specify the change of a chord length and the change of a stationary-blade exit angle about a direction, and the proposal about this was missing.

[0005]

[Problem(s) to be Solved by the Invention] With the conventional technology indicated to JP,61-47285,B, it does not become the radical solution about the secondary flow loss reduction generated in the low aspect ratio paragraph of axial-flow turbines, such as a steam turbine and a gas turbine. Because, it will change greatly with size of the aspect ratio as which the magnitude of the secondary flow loss generated in the paragraph of the above axial-flow turbines is expressed in the ratio of the length of a wing and a chord length, and the effect to which it does to paragraph effectiveness will also change with aspect ratios inevitably. Therefore, it cannot be overemphasized that the proposal which carried out concrete [of the content of the conventional technology indicated to JP,61-47285,B] further is substantially required.

[0006] The object of this invention is by aiming at an improvement of the paragraph effectiveness of axial-flow turbines, such as a scale, a steam turbine, and a gas turbine, for reduction of the secondary flow loss generated in a low aspect ratio paragraph to offer energy saving of a power generating plant.
 [0007]

[Means for Solving the Problem] In order that this invention may cancel a defect seen by JP,61-47285,B proposed previously Inside of two or more stationary blades and buckets which constitute a paragraph of axial flow fluid machinery, such as a steam turbine and a gas turbine, In a stationary blade which made angular distance of a stationary blade max in the center section of the length of a wing, and carried out the stacking so that it might reduce gradually as a side attachment wall of an aerofoil head and a blade root is approached from a center section of the length of a wing It is characterized by determining a direction coordinate. the length of a wing of a stationary blade -- it changes according to an elliptic curve to which change of a chord length about a direction makes a parameter the length of a wing and a chord length of a stationary blade -- as -- a hoop direction coordinate of a stationary-blade trailing edge, and the length of a wing -- And a stationary-blade exit angle of a stationary-blade center section, the head side-attachment-wall section, and the bottom side-attachment-wall section (sin1 (second/t) s:throat length, t: stationary-blade pitch) (the length of a wing and a chord length of a stationary blade are decided by constant formula made into a parameter) furthermore, the length of a wing of a stationary-blade exit angle -- stationary-blade structure of a turbine where change of a direction was characterized by changing according to a quadratic curve of arbitration which connected the three above-mentioned points is proposed.

[0008]

[Function] Although this invention tends to cancel the nonconformity of the conventional technology in which JP,61-47285,B previously proposed by providing the above means sees, the operation is explained hereafter. The stationary-blade structure which carries out a stacking so that it may reduce gradually as angular distance of a stationary blade is made into max in the center section of the length of a wing in JP,61-47285,B in order to control the secondary flow loss which developed into the side attachment wall of the aerofoil head of a low aspect ratio paragraph or a blade root, and the side attachment wall of the aerofoil head from the center section of the length of a wing and a blade root is approached, and sets more greatly than an aerofoil center section the stationary-blade exit angle of the aerofoil point and blade-root section as min for the exit angle of a stationary blade in the aerofoil However, if it is remarkably dependent on the magnitude of an aspect ratio and an aspect ratio becomes small, as for secondary flow loss, it is common that secondary flow loss increases substantially. therefore, it proposed by JP,61-47285,B -- as -- only -- the length of a wing -- only specifying size relation for the chord length and stationary-blade exit angle of a direction -- inadequate -- actual -- a design problem -- being inapplicable -- the magnitude of an aspect ratio -- responding -- the length of a wing -- it is important to set up the chord length of a direction and change of a stationary-blade exit angle. then -- this invention -- the length of a wing of a stationary blade -- it changes according to the elliptic curve to which change of the chord length about a direction makes a parameter the

length of a wing and the chord length of a stationary blade -- as -- the hoop direction coordinate of a stationary-blade trailing edge, and the length of a wing -- it proposes determining a direction coordinate. and the stationary blade exit angle (sin1 (second/t) s:throat length, t: stationary blade pitch) (the constant formula which make a parameter the length of a wing and the chord length of a stationary blade -- decide -- further -- the length of a wing of a stationary blade exit angle -- the stationary blade structure of a turbine where change of a direction be characterized by change according to the quadratic curve of the arbitration which connected the three above-mentioned points be propose.) of a stationary blade center section, the head side attachment wall section, and the bottom side attachment wall section By this proposal, corresponding to the stationary blade from which an aspect ratio differs, the secondary flow generated near the side attachment wall of a stationary blade can be controlled, and it can contribute to an improvement of the paragraph effectiveness of axial-flow turbines, such as a steam turbine and a gas turbine.

[0009]

[Example] hereafter, the details of the example of this invention and a deformation example are come out of and explained using drawing 15 from drawing 1 and drawing 8 .

[0010] Drawing 1 shows the stationary-blade structure of the typical turbine paragraph which applied this invention. Stationary-blade structure is constituted by the periphery diaphram 3 and the inner circumference diaphram 4 which carry out fixed maintenance of two or more stationary-blade 20a depended on this invention, and 20b--. These stationary blades 20a and 20b -- It connects with the internal surface 14 of the periphery diaphram 3, and point profile 21a and 21b-- are the aforementioned stationary blades 20a and 20b. -- Bottom section profile 22a and 22b-- have connected with the external wall surface 15 of the inner circumference diaphram 4. The shape of a profile is formed of back configuration 16a and intrados configuration 16b, and stationary-blade height serves as the length of these stationary-blades 20a and 20b-- specified with the depth Hn of the internal surface 14 of the periphery diaphram 3, and the external wall surface 15 of the inner circumference diaphram 4. In this case, stationary blades 20a and 20b -- The profile holds the configuration [**** / each other] of profile 23a of the center section (a PCD cross section is called) of the depth Hn, 23b-- and bottom section profile 22a, and 22b-- with point profile 21a and 21b--, and the profile 23 of a PCD cross section has the shape of a bigger profile than the point profile 21 and the bottom section profile 22. That is, the chord length Cp of the profile 23 of a PCD cross section is formed with a bigger profile than the chord length Ct of the point profile 21, and the chord length Cr of the bottom section profile 22. Although it had stopped at the content which prescribed the chord length of the height direction of a stationary blade that JP,61-47285,B proposed previously mentioned above, when the aspect ratio expressed with the ratio of the height Hn of a stationary blade and the chord length Cn of a stationary blade changes variously only by this proposal, it will be difficult to specify quantitatively the magnitude of the chord length Ct of an aerofoil point to the chord length Cp of an aerofoil center section, and the chord length Cr of the blade-root section.

[0011] The feature of this invention is to offer a proper means according to a stationary-blade aspect ratio, when changing a chord length in the height direction of a stationary blade in this way. Drawing 8 is VIII-VIII view drawing of the turbine stationary-blade structure shown in drawing 1 . The first transition line 18 of a stationary blade 20 crosses a right angle mostly to the internal surface 14 of periphery diaphram, and the external wall surface 15 of inner circumference diaphram. On the other hand, the trailing-edge line 31 of a stationary blade 20 crosses with the curve which had a certain inclination to the internal surface 14 of periphery diaphram, and the external wall surface 15 of inner circumference diaphram. Below, how to decide the trailing-edge line 31 of this stationary blade 20 is explained. The curve 32 in drawing is an elliptic curve expressed with the degree type which makes a major axis Hn (Hn: length of a wing of a stationary blade), and makes a minor axis Cn (Cn: chord length of an aerofoil center section).

[0012]

[Equation 2]

$$\frac{X^2}{\left(\frac{Cn}{2}\right)^2}+\frac{Y^2}{\left(\frac{Hn}{2}\right)^2}=1 \qquad \cdots(数2)$$

[0013] Therefore, the zero of an elliptic curve 32 is an intersection of the axis 26 which passes along one

half of the length of a wing of a stationary blade, and the axis 25 which passes along one half of the chord lengths of an aerofoil center section. and the length of a wing of the point A that the segment to which an axis 25 and the segment 24 used as the shape of a basic form of the trailing-edge line 31 of a stationary blade 20 cross at right angles through the focal coordinate f of an elliptic curve 32 and -f, and an elliptic curve 32 cross, Point B, and a stationary blade 20 -- it is a part of elliptic curve 32 which connects the trailing-edge point P in the medial axis of a direction. In addition, the above-mentioned focal coordinate f and the length OF of -f and Zero O are determined by the degree type.
[0014]
[Equation 3]

$$OF=\sqrt{(Hn/2)^2-(Cn/2)^2} \qquad \cdots(数3)$$

[0015] Furthermore, the curve 31 which turns into a trailing-edge line of a stationary blade 20 eventually The amplification correction of the coordinate of a direction is made by the ratio of the length of a wing Hn of a stationary blade, and the focal length OF. in order to correct the deflection of the focal length OF and the length of a wing Hn of a stationary blade -- the length of a wing of the segment 24 (APB) of an elliptic curve 32 -- the trailing-edge point C of a stationary-blade point -- the internal-surface 14 top of periphery diaphram -- and the trailing-edge point D of the stationary-blade bottom section carries out on the external wall surface 15 of inner circumference diaphram. In addition, the trailing-edge point C of a stationary-blade point, the trailing-edge point D of the stationary-blade bottom section, and Point A and Point B on an elliptic curve 32 are on the same axis parallel to an axis 25. It is the example which illustrated the curve showing the trailing edge of the stationary blade 20 in case the aspect ratios as which drawing 12 has the ratio of the length of a wing of a stationary blade and a chord length expressed differ from drawing 9 . Drawing 9 , drawing 10 , and drawing 11 will have the fixed chord length of a stationary blade, an aspect ratio will be the example which showed the trailing-edge curve of one or more stationary blades, an elliptic curve will turn into a longwise curve in this case, the difference delta of the chord length of a stationary-blade point and the bottom section and the chord length of an aerofoil center section can be made small with the increment in an aspect ratio, and, moreover, the chord length of an aerofoil head and the bottom section will change according to the magnitude of an aspect ratio. Moreover, drawing 12 is the example for which the aspect ratio illustrated the trailing-edge curve of a stationary blade 20 expressed with one or less oblong elliptic curve. The elliptic curve used as the shape of a basic form of the stationary-blade trailing-edge section 36 in this case is 37, and an aspect ratio becomes smaller [the chord length of a stationary-blade head and a bottom] than an aerofoil center section further compared with the one or more above-mentioned examples. Moreover, drawing 13 shows the concrete stationary-blade structure which applied this invention according to the magnitude of the aspect ratio of a stationary blade. The curve which expresses the trailing-edge lines 40, 41, and 42 of stationary blades 37, 38, and 39 according to the aspect ratio of a stationary blade, respectively changes to a curve with a small aspect ratio so that clearly from these drawings.
[0016] The example shown in drawing 13 from drawing 8 becomes two steps eventually, in order for the means which makes the amplification correction of the basic elliptic curve to prescribe the trailing-edge line of a stationary blade 20. In order to avoid this method, it will become possible if the means of drawing 14 or drawing 15 is adopted. That is, as for drawing 14 , an aspect ratio applies some segments of one or more longwise elliptic curves to the trailing-edge line of a stationary blade, and drawing 15 is the example in which the aspect ratio applied a part of one or less oblong elliptic curve to the trailing-edge line of a stationary blade. These examples apply some segments of an elliptic curve 41 expressed with the following formula set up so that the intersection of the axis 26 which passes along one half of the length of a wing of a stationary blade, and the axis 25 which passes along one half of the chord lengths of a stationary blade might be made into a zero and the length OF of a focal coordinate might become the length of a wing of a stationary blade from a zero to the trailing-edge line 40 (EPF) of a stationary blade.
[0017]
[Equation 4]

$$\frac{X^2}{\left(\frac{Cn}{2}\right)^2}+\frac{Y^2}{\left(\frac{Hn}{2}\right)^2\left(\frac{Cn}{2}\right)^2}=1 \qquad \cdots(数4)$$

[0018] As mentioned above, it sets to the stationary blade which carried out the stacking so that it might consider as max in the center section of the length of a wing of the chord length of a stationary blade and might reduce gradually toward the side attachment wall of an aerofoil head and the blade-root section from the center section of the length of a wing. by specifying change of the trailing edge line from the point of a stationary blade to the bottom section by the elliptic curve which makes a parameter the chord length of a stationary blade, and the height of a stationary blade, it corresponds to the magnitude of the aspect ratio of a stationary blade -- making -- the length of a wing of a stationary blade -- it can opt for change of the chord length of a direction. Of course, it is because it thought that the elliptic curve only containing two parameters of the length of a wing of a stationary blade and the chord length showing the aspect ratio of a stationary blade was the most suitable for it when it is the target turbine cascade this time, although the configuration of the trailing-edge line of a stationary blade can be approximated with the high order function of arbitration.
[0019] although it decreases in monotone with the increment in a stationary-blade aspect ratio as the secondary flow loss generated in a turbine cascade was generally shown in drawing 16 , even if a stationary-blade aspect ratio changes like the conventional stationary blade in this case -- a chord length -- the length of a wing -- it is a case fixed in a direction (see the continuous line of drawing 17). however -- if a part of above-mentioned elliptic curve is applied as a trailing-edge line of a stationary blade like this invention -- the ratio of the chord length of an aerofoil point and the bottom section, and the chord length of an aerofoil center section -- it becomes possible to make it increase in monotone with the increment whose Ct/Cn is a stationary-blade aspect ratio, and secondary flow loss of a stationary blade can be reduced as shown in drawing 16 .
[0020] Thus, since the contact length of a stationary-blade surface area and a side attachment wall, and a working fluid decreases, it is effective for control of the secondary flow which progresses near the side attachment wall that the head of a stationary blade and the chord length of the bottom section can be made smaller than the chord length of an aerofoil center section, so that an aspect ratio is small.
[0021] Moreover, offering such stationary-blade structure makes the distance between aerofoils of the trailing-edge edge of a stationary-blade point and the bottom section, and the bucket first transition which follows increased in addition to the depressor effect of the secondary flow mentioned above, so that the aspect ratio of a stationary blade is small. this works as an operation which decreases the rate that the big flow of the speed deficit of the stationary-blade back wash generated by existence of the trailing edge of a stationary blade flows into a bucket, and serves as an effect which reduces additional loss of a bucket.
[0022] Moreover, with the stationary-blade structure which carried out the stacking so that the chord length of a stationary blade might be made into max in the center section of the length of a wing like this invention and it might reduce gradually toward the side attachment wall of an aerofoil head and the blade-root section from the center section of the length of a wing, the stationary-blade exit angle (alpha) pcd of a stationary-blade center section is set up inevitably smaller than the stationary-blade exit angle (alpha) tip of a stationary-blade point, and the stationary-blade exit angle (alpha) root of the stationary-blade bottom section. however, JP,61-47285,B proposed previously -- the length of a wing of the above-mentioned stationary blade -- the convention over change of the stationary-blade exit angle about a direction is not made, and, moreover, the proposal which can be chosen corresponding to the aspect ratio of a stationary blade is not made. this invention -- the length of a wing of this stationary-blade exit angle -- it proposes changing change of a direction according to the magnitude of the aspect ratio of a stationary blade. That is, the stationary-blade exit angle (sin1 (second/t), s:throat length, t: stationary-blade pitch) of a stationary-blade center section, the head side-attachment-wall section, and the bottom side-attachment-wall section is formulized by the following formula.
[0023]
[Equation 5]

静翼中央部：$(\alpha)pcd=(\alpha pcd)fv-[(\alpha tip)fv-(\alpha root)fv]/(Hn/Cn)$

静翼先端部：$(\alpha)tip=(\alpha tip)fv+[(\alpha tip)fv-(\alpha root)fv]/(Hn/Cn)$

静翼根元部：$(\alpha)root=(\alpha root)fv+[(\alpha tip)fv-(\alpha root)fv]/(Hn/Cn)$

…(数 5)

[0024] However, fv (alphapcd) : Exit angle fv of the stationary-blade center section of free vortex layout (alphatip) : The exit angle fv of the stationary-blade point of free vortex layout (alpharoot): The definition of the free exit angle above-mentioned stationary-blade exit angle of the stationary-blade bottom section of vortex layout would like you to refer to drawing 14 . Moreover, some supplementary information is added about free vortex layout. usually, the object took this time -- as -- layout of a stationary blade with a comparatively small aspect ratio -- the length of a wing -- the pressure of a direction asks from the relation between the conditions of a balance with the centrifugal force expressed with a degree type, and the Bernoulli's equation -- having -- this -- being based -- the length of a wing -- the axial velocity and circumferencial direction component of velocity of a direction -- texture ****.

[0025]

[Equation 6]

$$\frac{dp}{dr}=\frac{\gamma}{g}\frac{Cu^2}{r}$$

$$\frac{c\,dc}{g}=\frac{dp}{\gamma}$$

…(数6)

[0026] here p:stationary-blade outlet static pressure r: -- the length of a wing of a stationary blade -- direction radius location Cu:circumferencial direction component of velocity gamma: -- specific weight of a fluid g: -- gravitational acceleration In the c:absolute-outlet-velocity above-mentioned relation the length of a wing of a stationary blade -- in the paragraph of circulation regularity (free vortex) in a direction the length of a wing of a stationary-blade outlet -- the conditions that the axial velocity calcium of a direction is fixed -- bases -- it is -- this case -- the component of velocity Cu of a circumferencial direction, and a product with a radius r -- the length of a wing -- the conditions of being fixed are led to a direction and the relation between the stationary-blade exit angle alpha and a radius r becomes like a degree type.

[0027]

[Equation 7]

$$\tan(\alpha)fv=\frac{r}{(r)root}\tan(\alpha root)fv$$

…(数7)

[0028] Thus, in free vortex layout, if the diameter of a bottom and exit angle of a stationary blade become settled, the stationary-blade exit angle of the radius location of arbitration will also be decided. Then, the method of correcting a stationary-blade exit angle according to this magnitude in consideration of the effect of the aspect ratio of a stationary blade proposes further the method of a convention of the stationary-blade exit angle of this invention on the basis of the stationary-blade exit angle by the free vortex design method generally applied as a conventional stationary-blade design method as shown in the above-mentioned formula.

[0029] therefore -- according to the proposal of this invention -- the stationary-blade exit angle of criteria -- from the conventional free vortex layout -- large -- ****** -- it can set up without things and, moreover, can decide corresponding to the magnitude of the aspect ratio of a stationary blade. Namely, the exit angle (alpha) pcd of a stationary-blade center section becomes smaller than the exit angle of free vortex layout, so that the aspect ratio on the basis of the chord length of an aerofoil center section is small, and it is the exit angle (alpha) tip of a stationary-blade point and the bottom section further. root (alpha) becomes larger than the exit angle of free vortex layout, so that an aspect ratio is small. moreover, the length of a wing of the

stationary-blade exit angle of drawing 14 -- as for the point which the stationary-blade exit angle, an aerofoil center section, the aerofoil point of the above-mentioned stationary blade, and the bottom section, of three points is changed according to the quadratic curve of arbitration, and intersects the stationary-blade exit angle of the free vortex layout conventional by the aerofoil head side and the blade-root side further, it is desirable to make the secondary flow field depending on the aspect ratio of a stationary blade match so that direction distribution may show.
[0030] According to this example, from the content of JP,61-47285,B proposed previously, were unrealizable. In the stationary-blade structure which made the chord length of a stationary blade max in the center section of the length of a wing, and carried out the stacking so that it might reduce gradually as the side attachment wall of an aerofoil head and a blade root is approached from the center section of the length of a wing the length of a wing of a stationary blade -- it becomes possible to specify concretely change of the chord length of a direction, and change of a stationary-blade exit angle, and the stationary-blade structure which can control effectively the secondary flow notably generated in a low aspect ratio paragraph can be proposed.
[0031] Drawing 15 shows the effect of the paragraph improvement in efficiency by this invention which artificers verified by air-turbine experiment. the means which this showed to the above-mentioned example corresponding to the aspect ratio of a stationary blade -- the length of a wing -- the relation of the paragraph effectiveness difference of the stacking stationary blade of this invention and the conventional stationary blade and stationary-blade aspect ratio which offered as a sample the stationary blade which gave distribution of the chord length of a direction and a stationary-blade exit angle is expressed. The result is understood that the effect is large, when paragraph effectiveness of any stacking aerofoil of a stationary-blade aspect ratio improves and a stationary-blade aspect ratio increases it from an aerofoil especially conventionally.
[0032]
[Effect of the Invention] in order to cancel the defect seen by the conventional technology of JP,61-47285,B proposed previously according to this invention, it becomes possible to aim at improvement in the paragraph engine performance of axial-flow turbines, such as a steam turbine and a gas turbine, and it can contribute to energy saving at the well head-ized list of a power generating plant by proposing the concrete means which a substantial effect goes up as a secondary flow loss reduction measure of a low aspect ratio paragraph.

[Translation done.]